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**Title: A Database Study of visual outcomes and intraoperative complications of post-vitrectomy cataract surgery**

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**Dedication:**

This work is dedicated to the memory of Robert L Johnston, MD FRCOphth (1966-2016), who played a major role in designing this study and sadly passed away before the completion of the work.

**Collaborators:**

Clare Bailey – data collection, Arijit Mitra – data collection, Atul Varma – data collection, Martin Mckibbin – data collection, Muhammed Tahir – data collection, Nick Lee – data collection, and Peter Scanlon – data collection

**Keywords:**

Phacoemulsification, vitrectomy, complications

## **Abstract**

### **Purpose:**

To analyze the visual outcomes and rate of intraoperative complications of phacoemulsification surgery after prior pars plana vitrectomy.

### **Design:**

Retrospective multicenter database study

### **Participants:**

Eyes that underwent phacoemulsification between June 2005 and March 2015 at 8 sites in the United Kingdom

### **Methods:**

Study eyes were classified either as vitrectomized (prior PPV group) or non-vitrectomized (reference group) depending on the vitreous state at the time of cataract surgery. Eyes with multiple intraocular surgeries or history of ocular diseases known to cause cataract progression or increased risk of intraoperative complications during phacoemulsification were excluded.

### **Main Outcome Measures:**

Logarithm of the Minimum Angle of Resolution (logMAR) visual acuity (VA), rate of intraoperative complications, and time interval to cataract surgery.

### **Results:**

Eyes in the prior PPV group (n = 2,261) had worse preoperative logMAR VA ( $1.00 \pm 0.59$  vs  $0.63 \pm 0.54$ ,  $p < 0.001$ ), were from younger patients and had longer axial lengths than the non-vitrectomized group (n = 200,303). At all postoperative time points measured up to 24 weeks, mean vision was poorer in the prior PPV ( $0.38 \pm 0.47$  vs  $0.19 \pm 0.32$  at 4-12 weeks,  $p < 0.001$ ) and a smaller proportion of eyes achieved postoperative VA  $\leq 0.30$  logMAR (Snellen,  $\geq 20/40$ ) (64.4% vs 84.2% at 4-12 weeks,  $p < 0.001$ ). The rate of posterior capsular rupture was not different between the prior PPV (1.7%) and the non-vitrectomized (1.7%) groups, but the incidence of zonular

dialysis (1.3% vs. 0.6%) and dropped nuclear fragments (0.8% vs. 0.2%) were higher in the prior PPV group ( $p < 0.001$ ). The mean time interval between PPV and cataract surgery was 399 days. Increased age and the use of longer duration intraocular tamponade were associated with a decreased time duration to cataract surgery, whereas the diagnosis of diabetes was associated with a longer time duration ( $p < 0.001$ ).

**Conclusion:**

We found a significant improvement in VA with post-vitrectomy cataract surgery. However, compared to eyes without prior PPV, there was a worse mean postoperative vision of 0.2 logMAR units, a higher rate of zonular dialysis and dropped nuclear fragments, and a similar rate of posterior capsule rupture.

## Introduction

The surgical technique for pars plana vitrectomy (PPV) has evolved in the past decade, with expanded use for the treatment of various vitreoretinal disorders. Pars plana vitrectomy is commonly complicated by cataract formation or progression, occurring in a significant proportion of eyes, with up to 100% showing nuclear sclerotic cataract progression within 2 years postoperatively.<sup>1-4</sup> Although the underlying pathophysiologic process of post-vitrectomy cataract formation remains unclear, a number of predisposing factors have been proposed, including traumatic crystalline lens injury at the time of PPV, phototoxicity, and lens protein oxidation.<sup>5-7</sup>

Phacoemulsification cataract surgery in vitrectomized eyes may be associated with surgical challenges and an increased risk of operative complications.<sup>8-10</sup> Lack of vitreous support can result in an abnormally deep and fluctuating anterior chamber during phacoemulsification, increased mobility of the posterior capsule, and zonular instability. Furthermore, direct zonular or crystalline lens damage may occur during PPV, thereby increasing the risk of complications in subsequent cataract surgery. Additionally, the use of intraocular tamponade agents at the time of PPV may cause stretching of the zonules, leading to zonular weakness.<sup>11, 12</sup> While the effect of PPV on subsequent cataract surgery has been evaluated previously,<sup>10, 13-16</sup> studies are scarce and generally limited by their sample size. The percentages of eyes achieving postoperative vision  $\geq 20/40$  also widely vary in previous studies, ranging from 20% to 77%,<sup>13, 16, 21-24</sup> making it difficult to draw firm conclusions on visual outcomes in vitrectomized eyes. Additionally, there are contradictory reports regarding the safety of phacoemulsification after prior PPV surgery. Cole and Charteris reported an overall intraoperative complication rate of 12.5%, and Ahfat et al. reported a posterior capsular rupture (PCR) rate of 13.3%;<sup>13, 14</sup> in contrast, other studies have demonstrated a favorable safety profile, similar to that in non-vitrectomized eyes.<sup>15, 16</sup>

With the above-mentioned shortcomings of the current literature in mind, we conducted a large multicenter cohort study using electronic medical record (EMR) data collected from eight United Kingdom (UK) National Health Service (NHS) ophthalmology sites to evaluate the visual outcomes and rate of intraoperative complications in post-vitrectomy phacoemulsification cataract surgery. Additionally, we analyzed the time interval from PPV to cataract surgery and the factors influencing its duration including diabetic status, surgical complexity of prior PPV surgery, and the use of various intraocular tamponade agents.

## **Methods**

### **Data Extraction**

Anonymized cataract surgery data of 217,557 eyes collected between July 2003 and March 2015 at eight UK NHS hospitals using the same electronic medical record (EMR) system (Medisoft Ophthalmology, Medisoft Limited, Leeds, UK) were automatically extracted and pooled to a centralized database for analysis. All sites had large ophthalmology departments with a representative case mix of patients undergoing day-case cataract surgery, performed by a wide range of surgeons using modern phacoemulsification techniques. No particular surgeons were primarily involved in any of the study groups. Records included routinely captured patient level data, logged in standardized datasets developed by the UK Royal College of Ophthalmologists.<sup>17, 18</sup> Data extracted included: age, gender, pre- and postoperative visual acuity (VA), PPV status and indications, type of intraocular tamponade, presence and type of operative complications, diabetic status, need for further ophthalmic surgery, and the time interval from PPV to cataract surgery. The EMR software was designed to ensure consistent and compulsory recording of intraoperative complications; prior to saving the operative note, physicians are prompted to select from a list of common complications associated with a given procedure or select that ‘no complication’ has occurred. As data was fully anonymized at the time of extraction, individual eyes, including those of patients undergoing bilateral sequential surgery during the study period, were included and treated as independent units for the purpose of analysis. This study was conducted in compliance with the Declaration of Helsinki, the National Institute for Health Research (NIHR), and the UK Data Protection Act. Anonymized database analyses of this type do not require ethical permission as they are viewed as clinical audit/service evaluation, in line with UK guidance.<sup>19</sup> The Caldicott Guardian (who is responsible for overseeing data protection and ensuring confidentiality of patients’ information) at each center gave written approval for the automated anonymized data extraction.

### **Data Categorization and Selection Criteria**

Of the 217,557 eyes on which phacoemulsification cataract surgery was performed, 8,475 had PPV prior to or combined with cataract surgery, and 209,082 eyes underwent only phacoemulsification without prior or simultaneous vitreoretinal surgery. Successive filtration steps were applied with exclusion of eyes that underwent phacoemulsification combined with additional intraocular surgeries (7,597 eyes), other than phacoemulsification

combined with silicone oil removal, and eyes where cataract surgery was performed using non-phacoemulsification surgical techniques (677 eyes). Eyes with a history of ocular diseases or treatments known to cause cataract formation or progression, independent of PPV surgery, including uveitis, endophthalmitis, and epimacular brachytherapy were also excluded, as were eyes with conditions known to increase the risk of complications during phacoemulsification, including blunt or penetrating trauma, and pseudoexfoliation syndrome (315 eyes). As well, we excluded eyes with missing operative dates or missing preoperative vision data (2,094 eyes). Eligible for analysis were a total of 202,564 eyes: 2,261 eyes with prior PPV (vitrectomized group) and 200,303 non vitrectomized eyes (reference group). Figure 1 details the distribution of eyes and the process of filtering used.

For the purpose of analysis, we further classified the eyes in the prior PPV group based on the complexity and indication of PPV surgery into 4 groups: (1) complex vitrectomy (CV): PPV for complex retinal disease including advanced diabetic retinopathy necessitating delamination/segmentation and surgery for retinal detachment with proliferative vitreoretinopathy (PVR) more than grade B; (2) rhegmatogenous retinal detachment (RRD): including primary PPV  $\pm$  scleral buckle for RRD with PVR grade B or less; (3) vitreoretinal interface (VRI) disorders: PPV for macular hole, epiretinal membrane, and vitreomacular traction; and (4) vitreous opacities (VO): PPV for vitreous floaters and vitreous hemorrhage (VH) due to any cause except those associated with diabetic retinopathy requiring membrane delamination and/or segmentation.

### **Follow Up and Study Outcomes**

Standards of pre- and postoperative care for routine cataract surgery in UK NHS hospitals have been described in previous publications.<sup>20</sup> The outcome variables for this study were VA, the incidence of intraoperative complications, and the time interval from PPV to phacoemulsification cataract surgery. Visual acuity was recorded using Snellen fractions or logarithm of minimal angle of resolution (logMAR) units and Snellen acuities were converted to logMAR for the purpose of analysis. Visual acuity was defined as the best value of uncorrected or corrected distance VA available at each time period. Preoperative VA was that recorded closest to the date of cataract surgery, no more than three months prior. Follow-up was recorded as occurring during three different time periods: 0-4 weeks, 4-12 weeks, and 12-24 weeks. Visual acuity at 4-12 weeks was selected as the primary



postoperative VA time period and included in the text; visual acuity at other postoperative time points are detailed in table 2. We defined vision gain after cataract surgery as improvement of  $\geq 0.30$  logMAR units ( $\sim 3$  Snellen lines).

### **Statistical analysis**

Differences between mean pre- and postoperative VA were evaluated using paired, independent t-tests and chi square. To account for multiple testing in VA in-between groups, we used Bonferroni correction, resulting in a conservative p-value threshold for statistical significance of 0.003. We performed univariate and multivariate regression analyses to determine the impact of age, gender, type of intraocular tamponade, diabetic status, and indications for PPV surgery on the time duration from vitrectomy to cataract surgery; the p-value threshold used for statistical significance was 0.05. We used STATA version 13.0 to perform all the statistical analyses.

## **Results**

### **Patient Demographics**

There were 2,261 eyes the prior PPV group and 200,303 eye in the reference, non vitrectomized group eligible for analysis. (Figure 1). Eyes in the prior PPV group belonged to patients who were younger (mean  $\pm$  standard deviation [SD]  $65.0 \pm 9.8$  years) than in the reference group ( $74.9 \pm 10.5$ ) ( $p < 0.001$ ) and had longer axial lengths ( $24.3 \pm 1.6$ mm vs.  $23.4 \pm 1.0$  mm, respectively;  $p < 0.001$ ). Within the prior PPV group, patients' mean age was lower ( $59.0 \pm 10.8$  years) in the CV subgroup in comparison to the RRD ( $62.3 \pm 9.6$ ), VRI ( $69.6 \pm 7.1$ ), and VO subgroups ( $64.7 \pm 11.3$ ) ( $p < 0.001$ ). The mean axial length was higher in the RRD subgroup ( $25.1 \pm 1.6$  mm) than the VRI ( $23.6 \pm 1.2$ ), VO ( $23.9 \pm 1.3$ ), and CV subgroups ( $23.2 \pm 1.1$ ) ( $p < 0.001$ ). Baseline characteristics of both groups are shown in Table 1.

### **Visual Outcome**

#### *Baseline vision*

Preoperatively, there was a statistically significant difference in the mean VA between the prior PPV ( $1.00 \pm 0.59$  logMAR) and reference groups ( $0.63 \pm 0.54$  logMAR), with better vision noted in the reference group ( $p < 0.001$ ). A smaller proportion of eyes in the prior PPV group (12%) had baseline vision of  $\leq 0.30$  logMAR (Snellen,  $\geq 20/40$ ) as compared to reference group (35%) ( $p < 0.001$ ). Within the prior PPV group, the CV subgroup had worse baseline logMAR VA (mean  $\pm$  SD:  $1.26 \pm 0.74$ ) than the RRD ( $0.94 \pm 0.59$ ), VO ( $1.00 \pm 0.66$ ), and VRI ( $0.94 \pm 0.52$ ) subgroups ( $p < 0.001$ ).

### *Postoperative Vision*

Table 2 details the mean postoperative VA at all postoperative time points. Vision improvement was achieved in both the prior PPV and reference groups, postoperatively ( $p < 0.001$ ). However, we observed a worse mean postoperative VA in the prior PPV group as compared to the reference group; at 4-12 weeks, mean VA was  $0.38 \pm 0.47$  (~20/50 Snellen equivalent) in the prior PPV group and  $0.19 \pm 0.32$  (~20/30 Snellen equivalent) in the reference group ( $p < 0.001$ ).

To further assess improvement of vision after cataract surgery, we analyzed the proportions of eyes with visual gains of  $\geq 0.30$  logMAR units (~3 Snellen lines) and those achieving a postoperative VA of  $\leq 0.30$  logMAR (Snellen,  $\geq 20/40$ ). At 4-12 weeks, 858 eyes (81.2%) in the PPV group and 59,409 eyes (60.4%) in the reference group gained  $\geq 0.30$  logMAR units (~3 Snellen lines) ( $p < 0.001$ ). However, a smaller proportion of eyes achieved a postoperative VA of  $\leq 0.30$  logMAR (Snellen,  $\geq 20/40$ ) in the prior PPV group (681 eyes, 64.4%) as compared to the reference group (81,433, 84.2%) ( $p < 0.001$ ). Within the prior PPV group, fewer eyes in the CV subgroup (28.8%) achieved postoperative VA  $\leq 0.30$  logMAR as compared to the RRD (70.2%), VRI (56.14%), and VO (59.5%) subgroups. As well, fewer eyes in CV subgroup (53.0%) gained  $\geq 0.30$  logMAR units (~3 Snellen lines) as compared to the RRD (77.2%), VRI (71.8%), and VO (71.4%) subgroups, however, these differences did not reach statistical significance.

### **Intraoperative complications**

Table 3 shows the intraoperative complication rate in the prior PPV and reference groups. We did not find a significant difference in the overall rate of intraoperative complications between the prior PPV (4.3%) and reference groups (3.6%). Similarly, the rate of PCR did not differ between groups (1.7 % in both the prior PPV and reference groups). However, we found the rate of zonular dialysis and dropped nuclear/epinuclear fragments to be higher in the prior PPV group (1.3% and 0.8%, respectively) than in the reference group (0.6% and 0.2%, respectively;  $p < 0.001$ ). Within the prior PPV group, there was a trend toward a higher rate of PCR and zonular dialysis (4.1% and 2.4%, respectively) in the CV subgroup as compared to the RRD (1.6% and 1.5%), VRI (1.0% and 1.0%) and VO (3.0% and 1.3%) subgroups, however, these differences did not reach statistical significance.

### **Interval between pars plana vitrectomy surgery and phacoemulsification**

We found the mean ( $\pm$  SD) time duration from PPV to phacoemulsification cataract surgery to be 399 ( $\pm$  415) days

(range: 13 – 4365 days). Age and axial length were found to have a negative association with (shortened) the time interval to cataract surgery (Table 4). On the contrary, diabetic status was positively associated with (prolonged) the time interval to cataract surgery, with type I diabetes mellitus exhibiting a stronger positive association than type II. The influence of age, axial length and diabetic status was present in both univariate and multivariate analyses. Within the prior PPV group, we found significant differences between the prior PPV subgroups in the time duration from PPV to cataract surgery ( $p < 0.001$ ); the longest (mean  $\pm$  SD) duration was observed in the CV subgroup ( $1242 \pm 924$  days), followed by the VO ( $446 \pm 456$  days), VRI ( $376 \pm 280$  days), and RRD ( $313 \text{ days} \pm 266$ ) subgroups. Regarding the effect of tamponade use on the time duration to cataract surgery, we found the use of intraocular tamponade during prior PPV surgery to be associated with a significantly shorter time interval from PPV to cataract surgery (mean  $\pm$  SD;  $362.5 \pm 362$  days) as compared to when no tamponade was used ( $528.9 \pm 545$  days) ( $p < 0.001$ ). In eyes where intraocular tamponade was employed, air was associated with the longest duration to cataract surgery (mean  $\pm$  SD;  $581 \pm 669$ ), followed by SF6 ( $374 \pm 349$ ), C2F6 ( $351 \pm 317$ ), C3F8 ( $350 \pm 338$ ), and silicone oil ( $163 \pm 154$ ). We found significant differences in duration between air and C2F6, C3F8, and silicone oil. However, while SF6 was found to be significantly different from air in univariate analysis ( $p < 0.001$ ), this difference was not significant in multivariate analysis, Table 4.

## Discussion

In this multicenter clinical database study, we examined the visual outcomes and the incidence of intraoperative complications in post-vitrectomy phacoemulsification cataract surgery. We found that nearly two-thirds of vitrectomized eyes achieved a postoperative  $\leq 0.3$  logMAR VA (Snellen,  $\geq 20/40$ ) after cataract surgery. Compared to eyes without prior PPV, there was a worse mean postoperative vision of approximately 2 Snellen lines, a higher rate of zonular dialysis and dropped nuclear fragments, and a similar rate of posterior capsule rupture.

Significant variation exists in rate of the visual improvement reported in post-vitrectomy cataract surgery. Prior studies found that percentages of eyes achieving postoperative VA  $\geq 20/40$  range from 20% to 77%.<sup>13, 16, 21-24</sup> This wide range may reflect variation in patient selection and baseline VA and differences in the severity of pre-existing vitreoretinal pathology. In this report, we found that vitrectomized eyes had worse baseline VA (1.00 vs 0.63 logMAR, respectively) and showed a worse mean postoperative vision (0.38 vs 0.19, respectively) and a smaller potential for reaching a postoperative  $\leq 0.3$  logMAR VA (Snellen,  $\geq 20/40$ ) as compared to non-vitrectomized eyes (64.4% vs. 84.2 %, respectively) after cataract surgery. It is of note that the prior PPV group demonstrated better potential for gaining  $\geq 0.30$  logMAR units ( $\sim 3$  Snellen lines) from baseline as compared to the non-vitrectomized group (81.2% vs. 60.5%, respectively), which can be explained by a possible ceiling effect limiting the potential for improvement in the non-vitrectomized group with better baseline VA. Our data also suggests that visual gains after post-vitrectomy cataract surgery are largely dependent on the severity of vitreoretinal pathology and baseline vision. The CV subgroup had the poorest baseline vision and only approximately one-third of the eyes in this cohort achieved  $\leq 0.3$  logMAR VA (Snellen,  $\geq 20/40$ ) postoperative VA as compared to more than two-thirds of eyes in other prior PPV subgroups. Further, eyes in the CV subgroup showed significantly lower potential for significant visual gain ( $\geq 0.30$  logMAR units) as compared to other prior PPV subgroups, despite a worse baseline VA before cataract surgery. Taken together, these findings demonstrate the impact of pre-existing retinal pathology on visual outcomes in post-vitrectomy cataract surgery.

Previous studies on vitrectomized eyes though limited by their size, have shown variable rates of intraoperative complications with rates of PCR ranging from 0 - 13.3%, and zonular dialysis ranging from 0 - 6.7%. Table 5 details the rate of intraoperative complications in vitrectomized eyes observed in previous studies.<sup>10, 13-16, 25, 26</sup> In our study,

the rate of PCR was not significantly different between the prior PPV and reference groups. However, zonular dialysis and dropped lens fragments were more frequent in the prior PPV group. Improved fluidics of phacoemulsification surgery has considerably facilitated the maintenance of anterior chamber stability. This may have helped to reduce the mobility of the posterior capsule in vitrectomized eyes undergoing cataract surgery, thereby decreasing the risk of PCR. On the other hand, trauma to the zonules during prior PPV surgery or as a result of intraocular tamponade use is often unavoidable, and may account for the increased incidence of zonular dialysis in vitrectomized eyes and the higher rate of dropped nuclear fragments during subsequent cataract surgery.

The effect of age on post-vitrectomy cataract formation has been evaluated in previous studies. Melberg and associates found a lower incidence of cataract formation after PPV in younger patients; over 25 months, nuclear sclerosis developed in only 7% of patients younger than 50 as compared to 79% older than 50.<sup>27</sup> This finding was also replicated in another study which showed subtle progression of cataract after PPV in patients younger than 50.<sup>28</sup> In keeping with the findings of these studies, we found patient's age to significantly impact the time duration to cataract surgery, with younger age being associated with a longer time interval to post-vitrectomy cataract surgery.

Although cataract formation is two to four fold more common in eyes with diabetes,<sup>29, 30</sup> following PPV, these eyes may require cataract extraction after a longer duration than in non-diabetics. It has been proposed that diabetes may exert a protective effect against the development of post-vitrectomy cataract formation owing to substantially lower oxygen tension in the vitreous humor of diabetic eyes as compared to non-diabetic eyes. Such a reduction is presumed to protect against oxidative damage to the lens and thereby delay the progression of cataract formation.<sup>31</sup> Smiddy, et al. reported a lower rate of cataract extraction after vitrectomy in eyes with diabetic retinopathy (15%) as compared to those with macular hole (53%) and ERM (66%) within 2 years of follow-up.<sup>32</sup> In another study, cataract extraction was required in only 39% of diabetic eyes after 4 years of follow up.<sup>33</sup> Ostri, et al. reported the longest follow-up after PPV; in their study, cataract extraction was performed in about 30%, 67% and 71% within 2, 5 and 10 years, respectively.<sup>34</sup> In our study, we found diabetic status to be associated with an increased time interval from PPV to cataract surgery, with a longer duration in type I diabetics as compared to type II. While it is possible that the younger age of type I diabetics may play a role in this difference, the effect of diabetes was found to be independent of the effect of age in our multivariate analysis model.

In keeping with prior studies that associated the use of intraocular tamponade during PPV and its duration with the risk of subsequent cataract development,<sup>35</sup> we found the time interval between PPV and cataract surgery to be shorter with the use of intraocular tamponade as compared to when no tamponade was used. We also found this time interval to be negatively associated with the duration of the tamponade, with the exception of SF6 gas that was not significantly different from air. While silicone oil was associated with the shortest duration to cataract surgery, the majority (81%) of cataract surgeries in eyes with silicone oil were performed at the time of silicone oil removal. It is therefore possible that decision for removal of silicone oil may have influenced the timing of cataract surgery.

Regarding the effect of PPV indication on the time of subsequent cataract surgery, we found the duration to be shortest in eyes where PPV was performed for RRD, followed by VRI disorders, then VO, and longest in the CV subgroup. In RRD surgery, more attention is paid to the removal of peripheral vitreous which may increase the risk of crystalline lens injury and accelerate the development of cataract. This is different from surgery for VO or VRI disorders where a more conservative vitrectomy approach is usually employed and surgery time is shorter. For the CV subgroup, it is of note that this cohort of eyes belonged to younger patients and included the highest proportion of diabetic eyes as compared to the other prior PPV subgroups (Table 1); these factors may at least in part explain the long duration to cataract surgery in this cohort despite increased surgical complexity.

Our study has limitations. First, it is limited by the by its non-controlled, retrospective design and therefore it may be argued that unaccounted differences in preoperative ocular co-morbidities between the study groups may have influenced the visual outcomes. Additionally, similar to other database studies, not all patients in our study had follow up data for all postoperative time points. However, the scale of this study meant that at any single time point, more than 600 prior PPV eyes and 76,000 non-vitrectomized eyes were analyzed; at the primary postoperative time point at 4-12 weeks, 1,057 prior PPV eyes were analyzed – an unparalleled resource from a single study.

Furthermore, we defined the distance VA as the best value of uncorrected or corrected distance VA available at each time point. It is therefore possible that including uncorrected VA values may have resulted in suboptimal final vision particularly in the post PPV eyes that may be more myopic and thus more likely to need postoperative refraction compared to the reference, non-vitrectomized group. However, because the standard of care for cataract surgery in the UK NHS includes a postoperative visit, 4 – 6 weeks post-surgery, in which eye refraction is routinely performed, we believe that the greatest proportion of distance VA values recorded at the primary postoperative VA time period (4-12 weeks) in this study are corrected values. Finally, we used the time interval from PPV to cataract surgery to

study different factors that could influence cataract progression after PPV such as patient's age, diabetic status and PPV surgery indication. However, time interval to cataract surgery may be also influenced by the varying degrees of crystalline lens opacification prior to PPV and the differences in threshold for performing cataract surgery between surgeons and these factors were not possible to analyze in this study.

As the indications for PPV are expanding and as cataract is by far the most common postoperative complication of PPV,<sup>36</sup> our results may well influence clinical practice – the presented data will allow more accurate planning and counselling of patients regarding the visual outcome and the risk of intraoperative complications for cataract surgery in this setting. An added strength of the study is because recording of intraoperative complications in the EMR is a compulsory field, under-reporting bias of surgery complications is expected to be minimal. Our study provides a large resource of a non-selective cohort of post vitrectomy eyes from multiple centers where all data were gathered into prospectively fixed data fields, then analyzed retrospectively. As such, our findings are more informative than small studies and avoid the potential selection bias inherent to studies originating from single institutions.

In summary, we found that approximately two-thirds of eyes undergoing post-vitrectomy phacoemulsification cataract surgery experienced increased vision; however, mean postoperative vision was approximately 2 lines worse than non-vitrectomized eyes and those with more complex vitreoretinal pathology were less likely to achieve VA  $\geq$  20/40 after cataract surgery. We also found that the time interval to cataract surgery after PPV was shorter with prior use of longer acting intraocular tamponade agents and more prolonged in type 1 diabetics and younger patients. While the rate of PCR in vitrectomized eyes was comparable to non-vitrectomized eyes undergoing cataract surgery, there was a higher rate of zonular dialysis and dropped nuclear fragments in vitrectomized eyes.

#### **Table Legends:**

**Table 1.** Baseline demographics of the prior pars plana vitrectomy group and the reference (non-vitrectomized) group

**Table 2.** Logarithm of the minimum angle of resolution (logMAR) vision of the prior pars plana vitrectomy group and the reference (non-vitrectomized) group at different time points.

**Table 3.** List of intraoperative complications in the prior pars plana vitrectomy group and the reference (non-vitrectomized) group

**Table 4.** Univariate and multivariate analysis of factors affecting the interval to cataract surgery in eyes with previous pars plana vitrectomy.

**Table 5.** Rate of intraoperative complication of phacoemulsification in vitrectomized eyes in previous studies.

### Figure Legends:

**Figure 1.** Flowchart illustrating the filtering process used to obtain the prior pars plana vitrectomy group and the reference (non-vitrectomized) group.

**Figure 2.** Bar graph (mean  $\pm$  95% confidence interval) illustrating visual acuity, expressed in logarithm of the minimum angle of resolution (logMAR), at baseline and different postoperative time points (in weeks) after phacoemulsification surgery in the prior pars plana vitrectomy group and the reference (non-vitrectomized) group

Preop = preoperative; and PPV= pars plana vitrectomy.

### Competing Interests:

None of the authors have any competing interests in the manuscript.

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